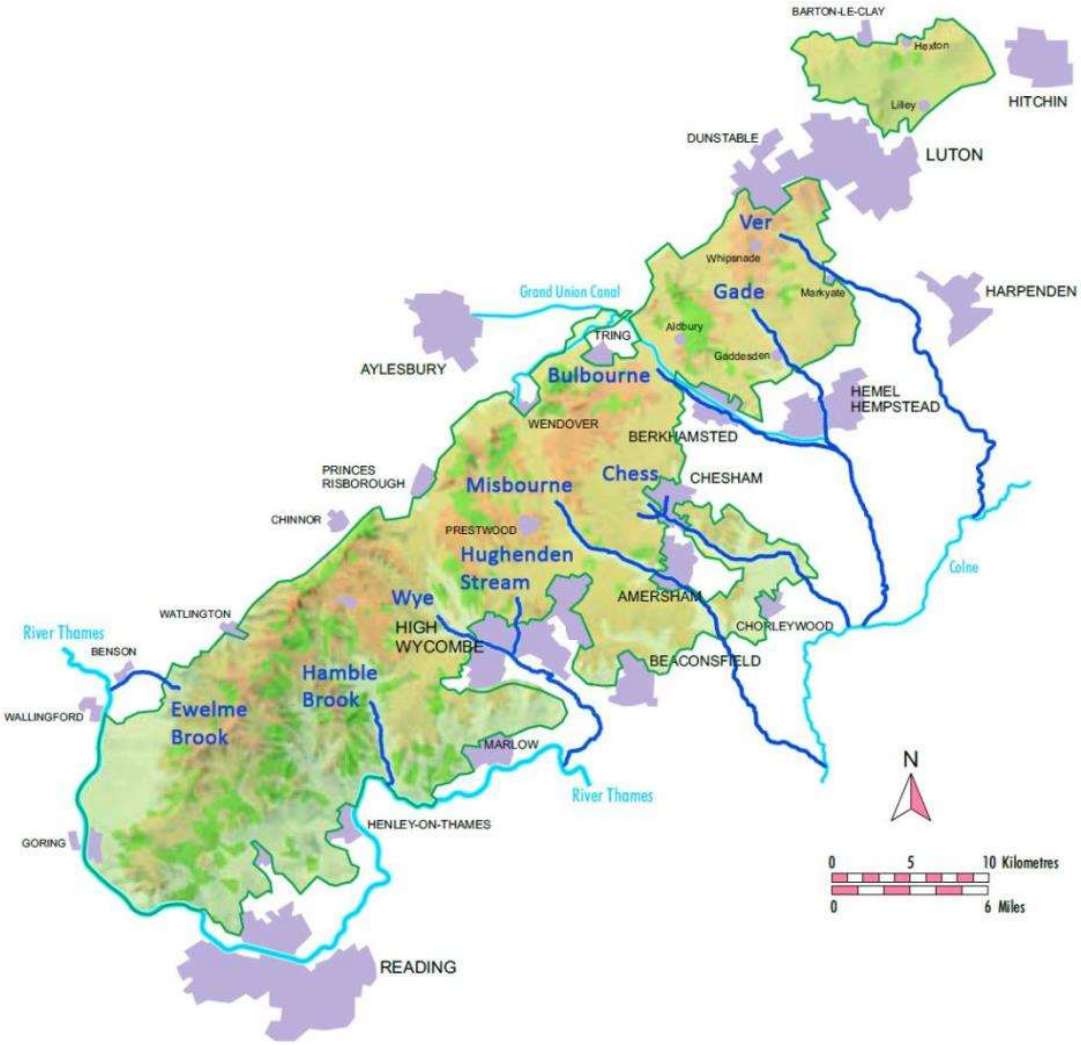
Chilterns Chalk Streams Project

CHILTERNS
CHALK STREAMS
PROJECT

Chilterns Streams

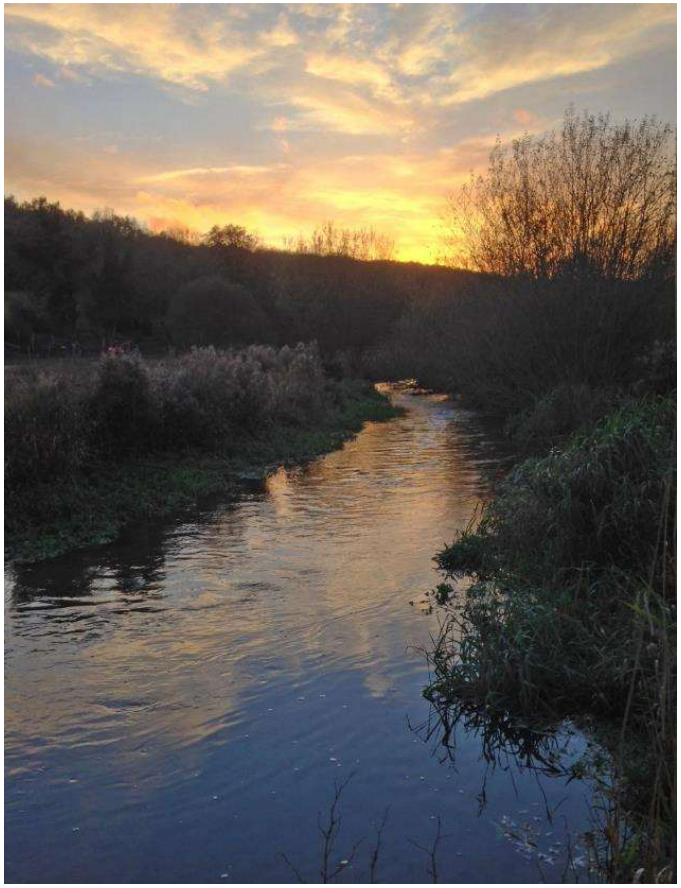


Chilterns Chalk Streams Project

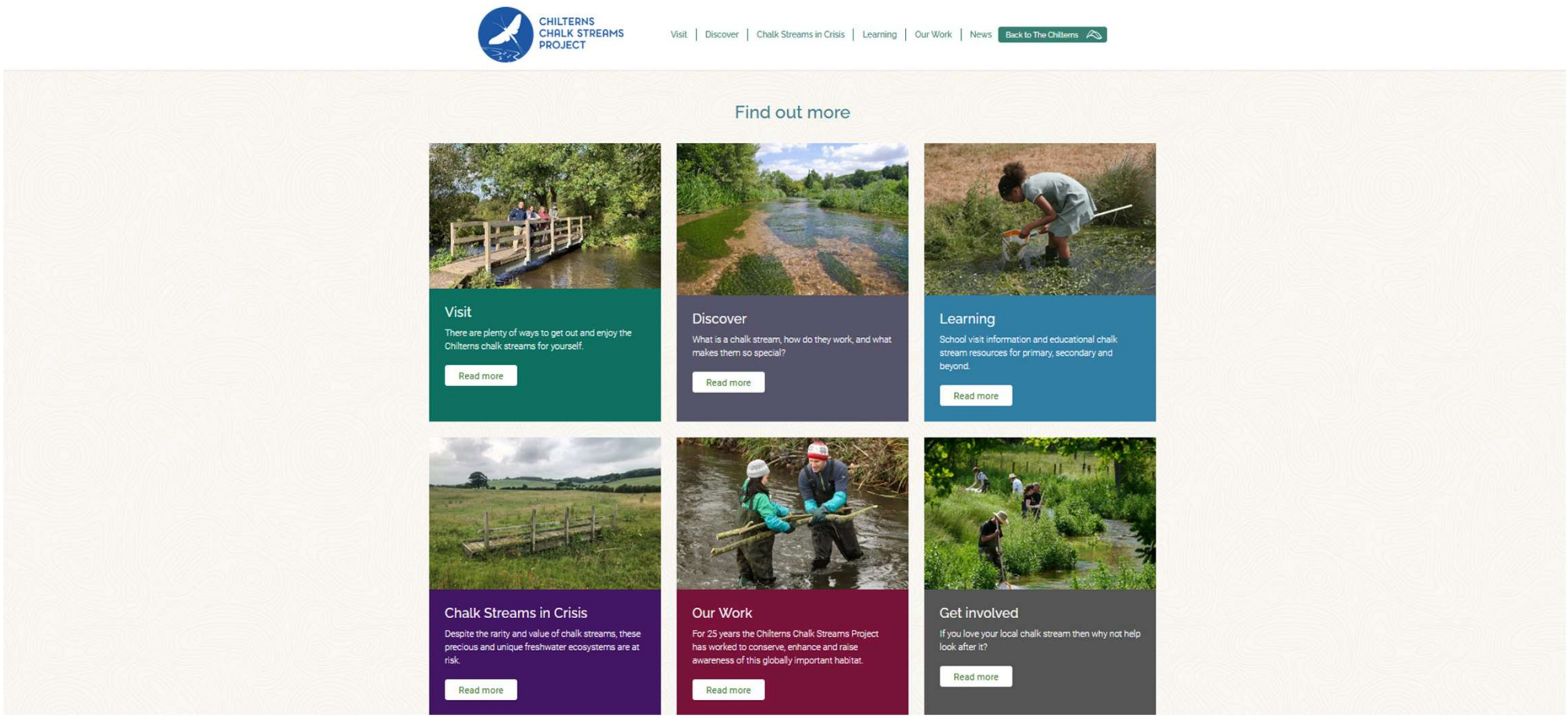
- Created in 1997
- Prompted by low flows in the 1990's
- Partnership Project
- Led by Chilterns Conservation Board

Objectives

- Raising awareness
- Improving physical access
- Providing advice to landowners/ managers
- Education and Engagement
- Practical Conservation and River Restoration



www.chilternstreams.org



Enquiry-based learning into water management: a case study using the River Chess

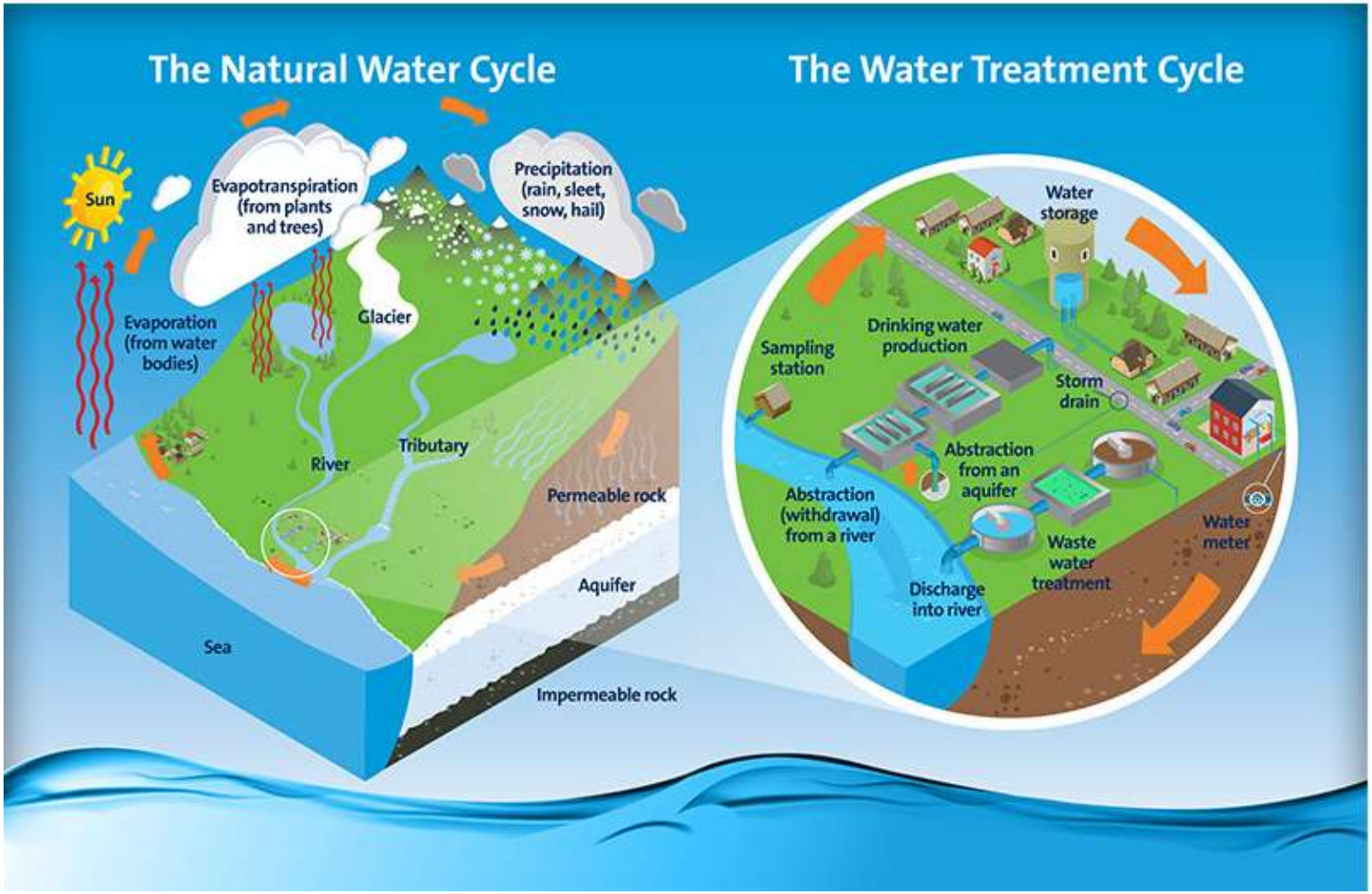
INTRODUCTION TO THE WORKSHOP

- To introduce you to some of the challenges faced by river managers in a changing world
- To provide you with the material to enable enquiry-based learning concerning the water cycle and water management
- To introduce you to the educational resources available on our Chilterns Chalk Streams Project website: https://www.chilternstreams.org/learning/secondary/
- To signpost potential virtual learning activities for your students in water science

ENQUIRY-BASED LEARNING MATERIAL

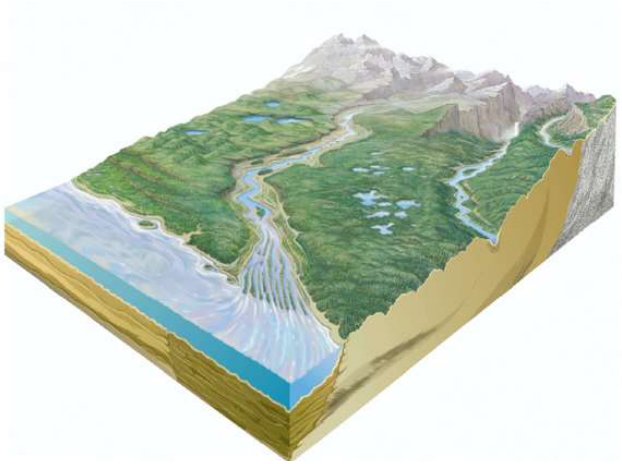
Good enquiry-based learning (EBL) has four essential characteristics (Roberts, 2003):

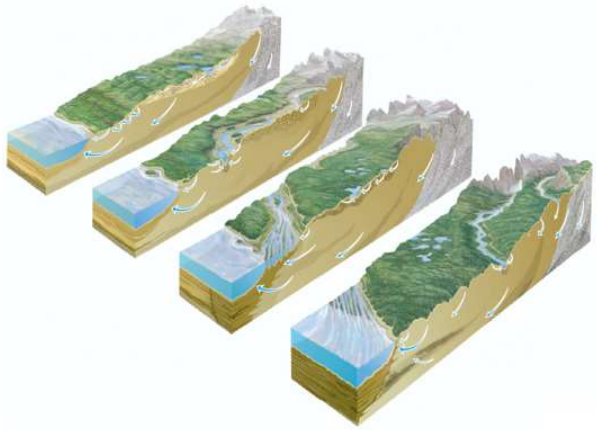
- it is question driven and encourages a questioning attitude towards knowledge
- students study geographical data and sources of information as evidence
- students make sense of information for themselves in order to develop understanding
- students reflect on their learning



SOURCE: Affinity Water

GROUNDWATER

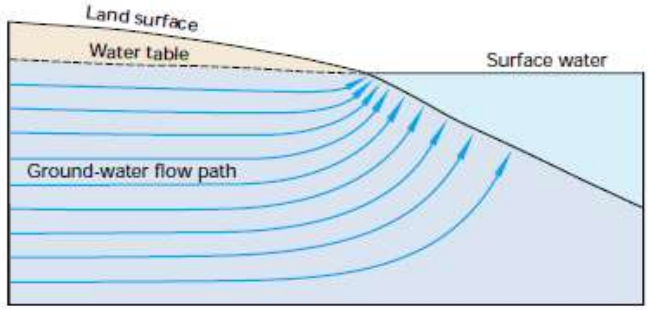




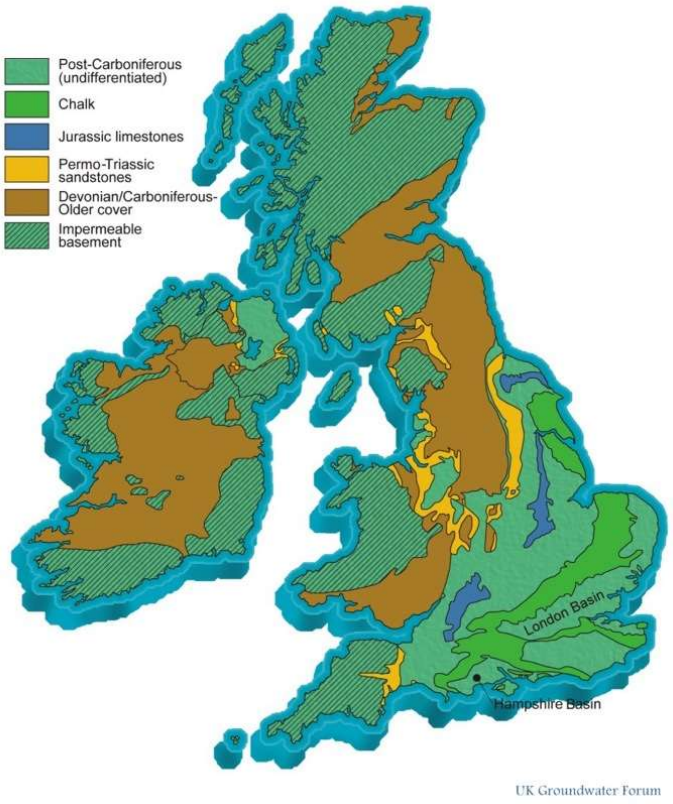
- Groundwater flows occur throughout the landscape from the mountain to the oceans

- You can think of them as nested loops of
- water flows with different travel times.

- Flow paths can be tens of metres to tens of miles in
- length with travel times of days to millennia.



MAJOR AQUIFERS OF THE UK



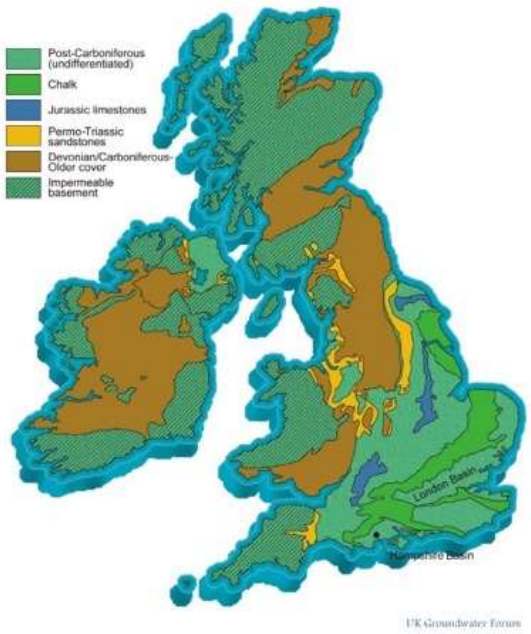
An **aquifer** is a permeable rock that stores groundwater and allows water to flow readily into a well or borehole.

The rocks have high *porosity* (i.e. volume of pore space). These pores spaces must be well connected to allow water flow (i.e. be *permeable*).

Most groundwater circulates in upper 100 to 200 metres of saturated zone.

Principal aquifers are:
- Chalk
- Permo-Triassic sandstone
- Jurassic limestone
- Lower Greensand

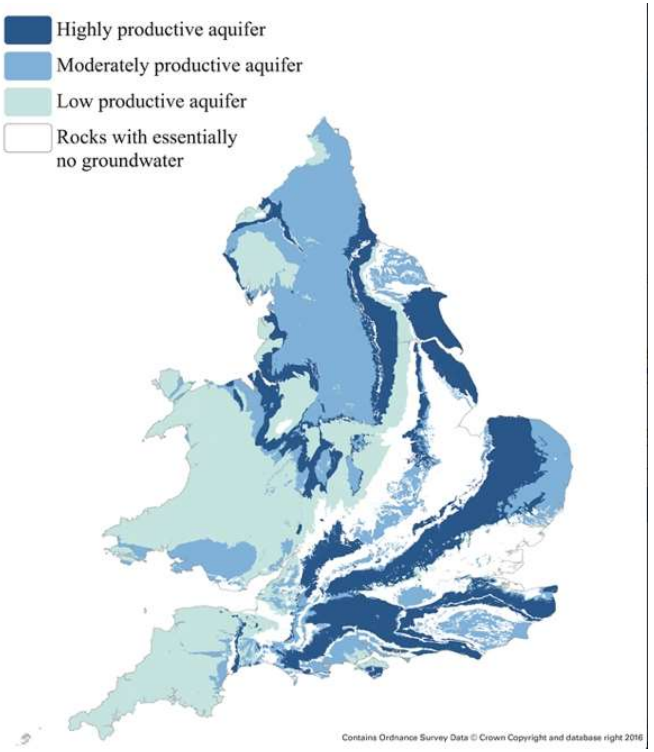
USE OF GROUNDWATER FOR PUBLIC WATER SUPPLY

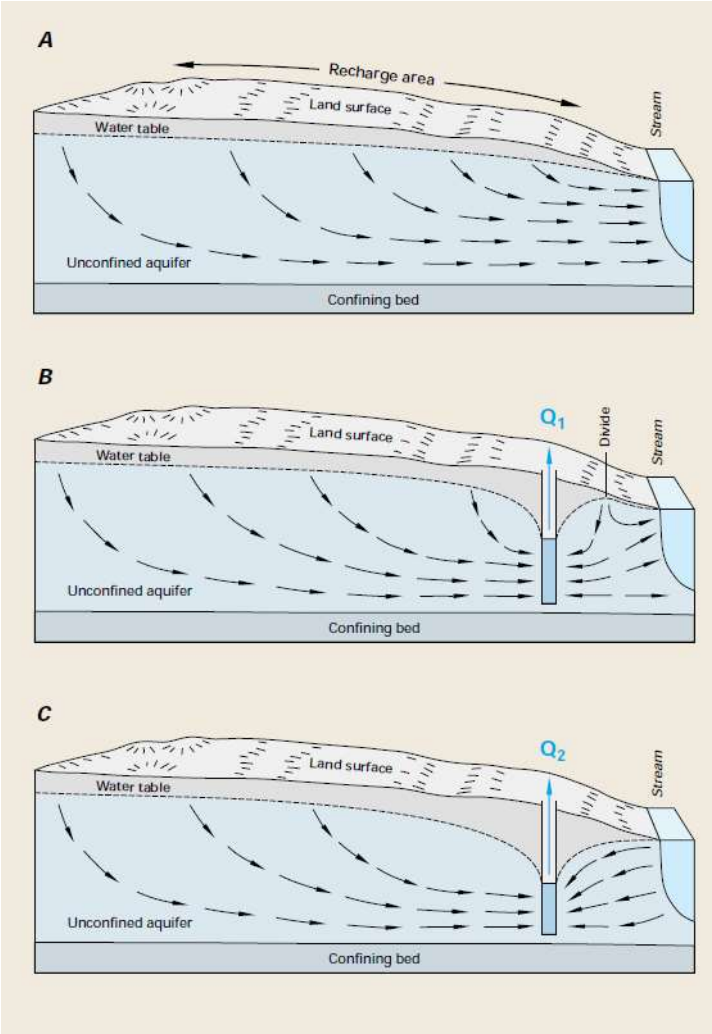


Groundwater supplies 30% of public water supply in England and Wales

6064 Mega Litres each day – enough to run a dishwasher 400 million times every day

Crucial supply of water for:
- Domestic use
- Agricultural use
- Industrial use

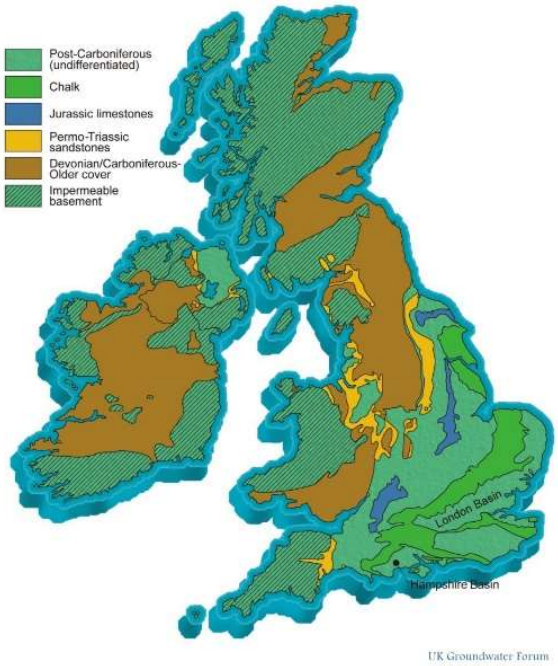


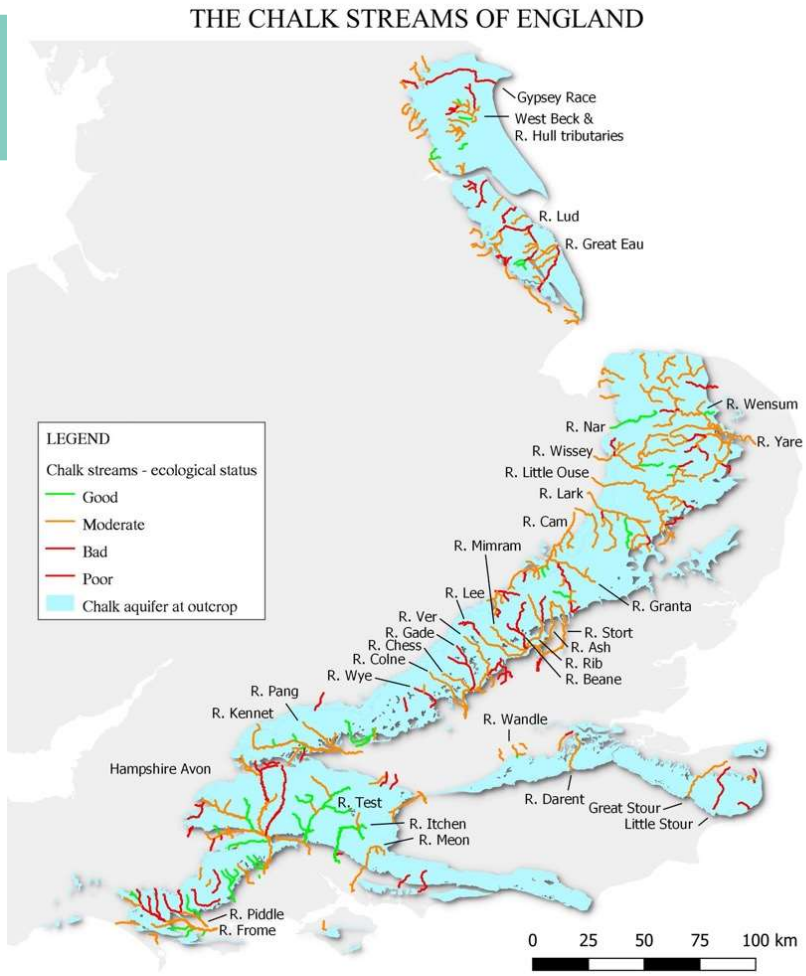

A
Recharge area
Land surface
Water table
Stream
Unconfined aquifer
Confining bed
B
Q_1
Divide
Land surface
Water table
Stream
Unconfined aquifer
Confining bed
C
Q_2
Land surface
Water table
Stream
Unconfined aquifer
Confining bed

CHALK STREAMS

- Groundwater-fed rivers (> 200) - water is predominantly from chalk aquifer
- Clear, alkaline, mineral-rich water
- Ecologically rich (in-stream plants, fish & animals)
- Internationally important – England has 85% of the world's chalk streams

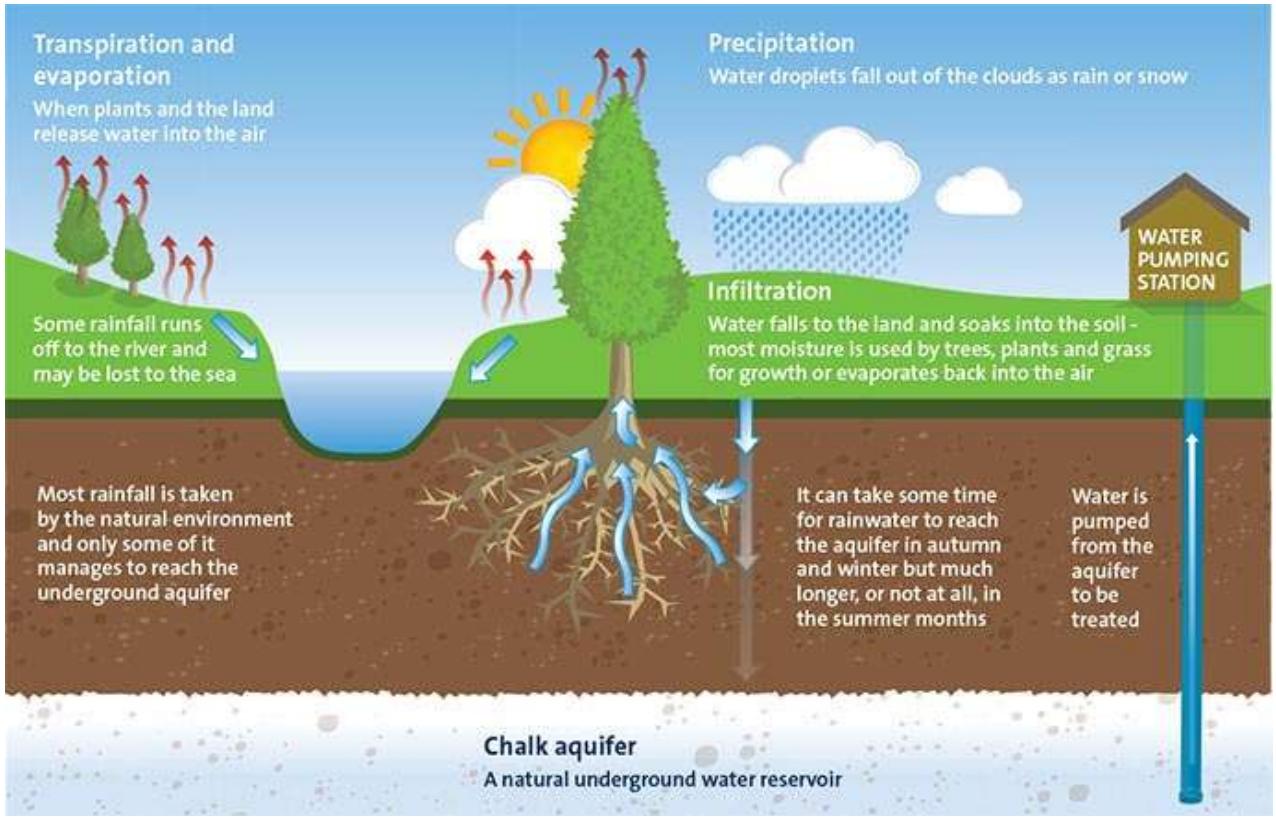
WHERE ARE CHALK STREAMS?





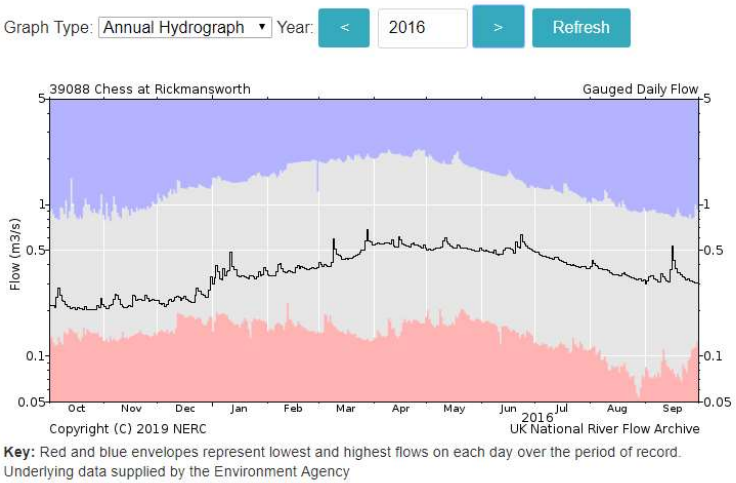
List of chalk streams from: WWF-UK, 2014: The State of England's Chalk Streams.
http://assets.wwf.org.uk/downloads/wwf_chalkstreamreport_final_lr.pdf

THE HYDROLOGICAL CYCLE IN CHALK CATCHMENTS

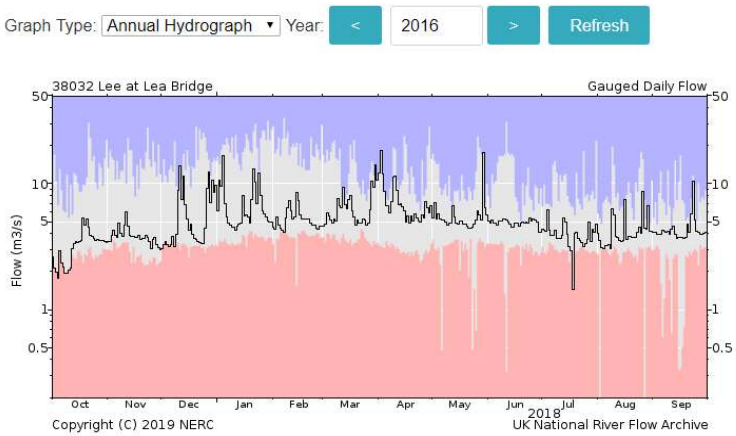


This image is from Affinity Water website: https://www.affinitywater.co.uk/water-cycle.aspx

NATURAL VARIATIONS IN FLOW IN A CHALK STREAM



Key: Red and blue envelopes represent lowest and highest flows on each day over the period of record. Underlying data supplied by the Environment Agency



Key: Red and blue envelopes represent lowest and highest flows on each day over the period of record. Underlying data supplied by the Environment Agency

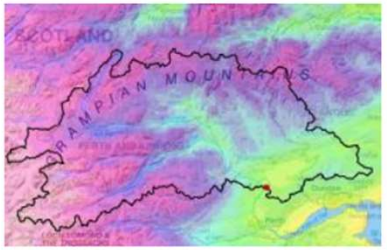
River Chess, Chilterns

Underlying geology is chalk

River Lee, North London

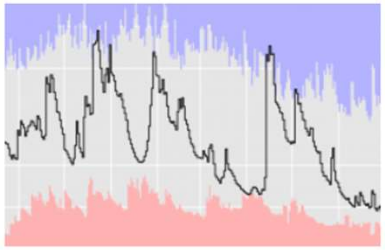
Underlying geology is clay

NATIONAL RIVER FLOW ARCHIVE



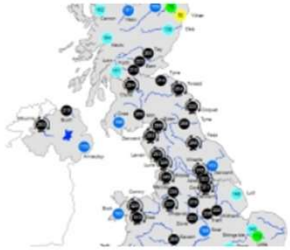
Search Data

Search for gauging stations using our interactive map and download metadata.



About Data

Learn about the archives, the data the NRFA holds and how the data can be interpreted and used.



National Hydrological Monitoring Programme

The voice on hydrological conditions throughout the UK.

Peak Flow Dataset

Download the NRFA Peak Flow Dataset for use in WINFAP software for flood estimation.

UK Water Resources Portal

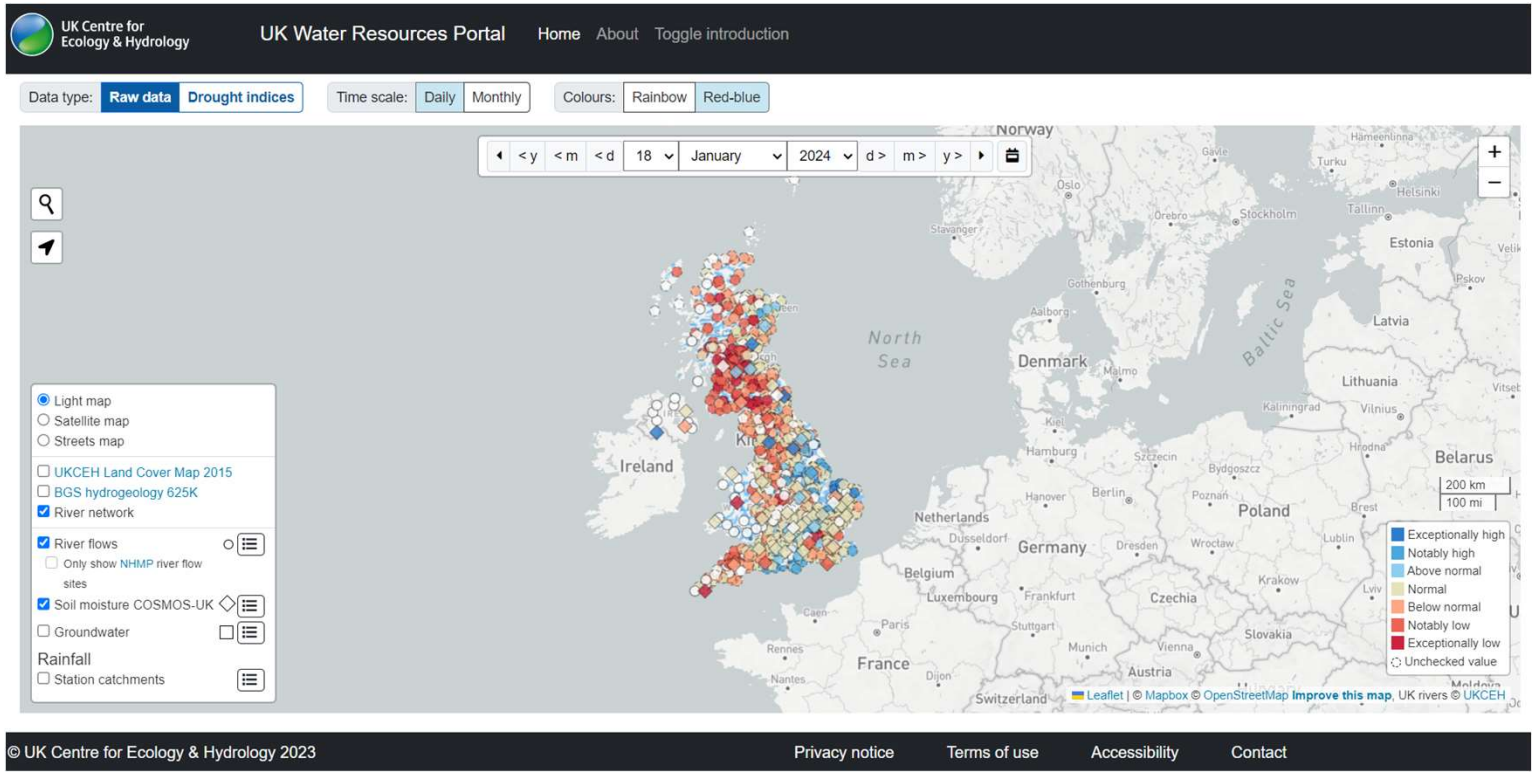
Track latest hydrological situation across the UK via our new portal.

About NRFA

Learn about what the NRFA does, our history, partnerships and national and international roles.

nrfa.ceh.ac.uk

UK WATER RESOURCES PORTAL

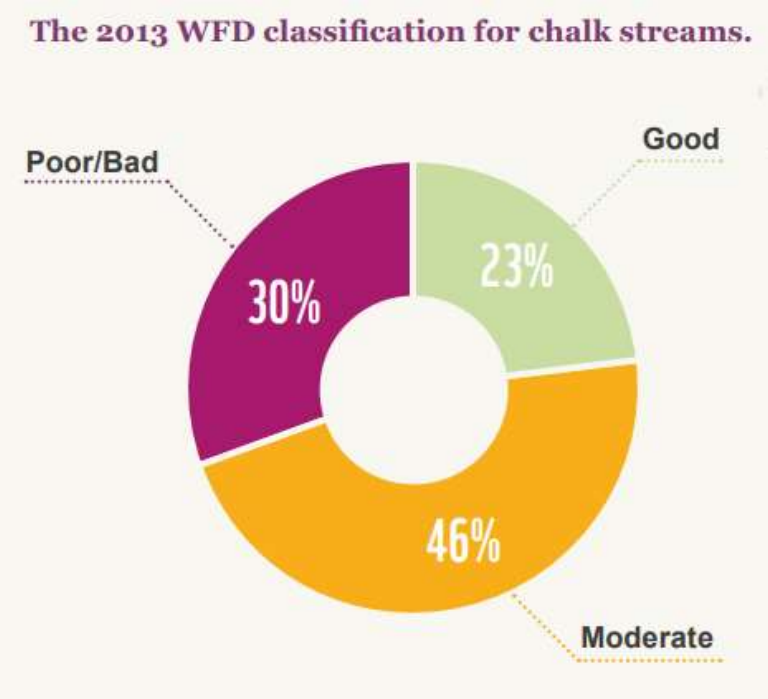


https://nrfa.ceh.ac.uk/content/uk-water-resources-portal

PRESSURES ON CHALK STREAMS

Flows and water quality in chalk streams are under increasing pressure from:

- Abstraction for drinking water
- Agricultural activities
- Urban runoff
- Sewage inputs



RIVERS IN THE CHILTERNS

Water Framework Directive assessment of Chilterns Chalk Streams (2019)					
River	Ecological	Chemical (overall)	Specific chemicals	Hydrological regime	Morphology
Bulbourne	Poor	Fail	PBDE, PFOS, Dissolved oxygen (moderate)	Does not support good	Supports good
Chess	Moderate	Fail	PBDE, Phosphate (poor)	Does not support good	Supports good
Ewelme Brook	Moderate	Fail	Hg, PBDE,PFOS, cypermethrin Phosphate (moderate)	High	Supports good
Gade (upper)	Poor	Fail	PBDE, Dissolved oxygen (moderate)	Does not support good	Supports good
Gade (lower)	Moderate	Fail	PBDE, PFOS, Phosphate (moderate)	Does not support good	Supports good
Hamble Brook	Poor	Fail	Hg, PBDE,PFOS,	Does not support good	Supports good
Hughenden Stream	Moderate	Fail	Hg, PBDE	High	Supports good
Misbourne	Moderate	Fail	PBDE	Does not support good	Supports good
Ver	Moderate	Fail	PAHs, PFOS, PBDE Dissolved oxygen (moderate)	Does not support good	Supports good
Wye (upper)	Moderate	Fail	PAHs, Hg, PBDE	Supports good	Supports good
Wye (lower	Poor	Fail	PAHs, Hg, PBDE, PFOS	Supports good	Supports good

KEY
- Poor
- Moderate
- Fail
- Does not support good
- High
- Supports good

WHY ARE SO MANY CHILTERN CHALK STREAMS NOT AT GOOD ECOLOGICAL STATUS?

Low flows

- Low rainfall
- Low water availability (public water supply)
- High levels of water demand
- High levels of planned housing growth

Water quality

- Siltation of gravels
- High nitrate and phosphate concentrations
- Sewage discharge

Consequences for ecology

- Poor invertebrate & fish communities

THE CHALK AQUATIC ECOSYSTEM

What do we look for in an aquatic ecosystem?

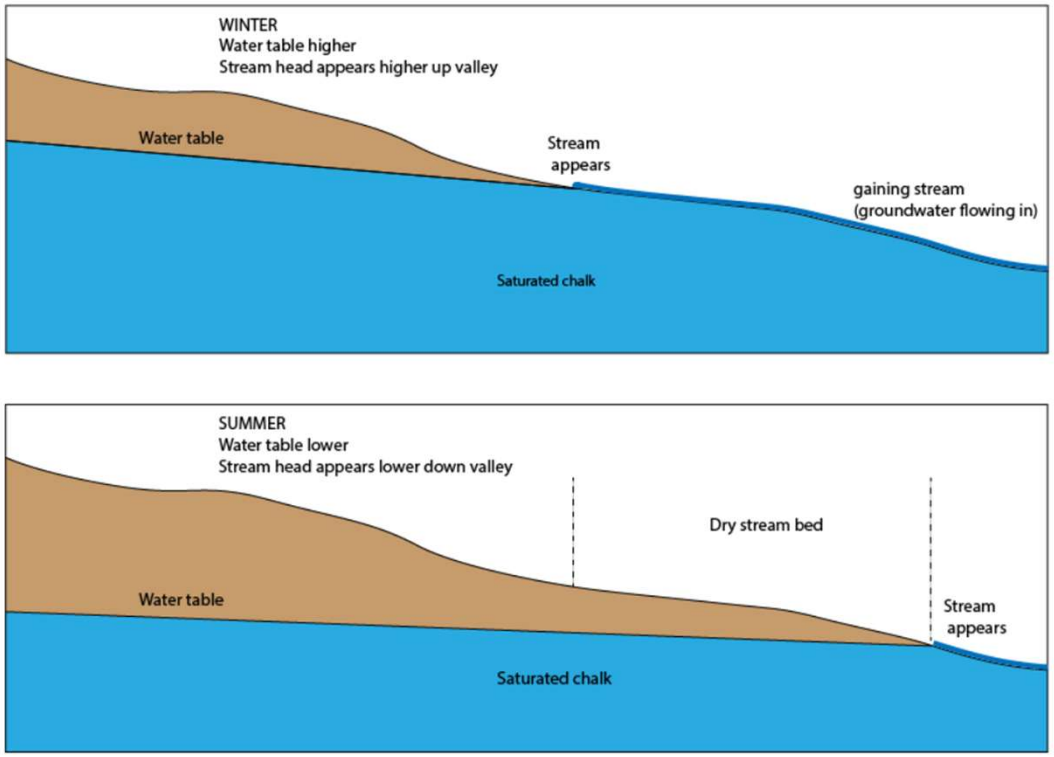
Animals
Fish
Insects
Plants

How does each element link and interact as a system?

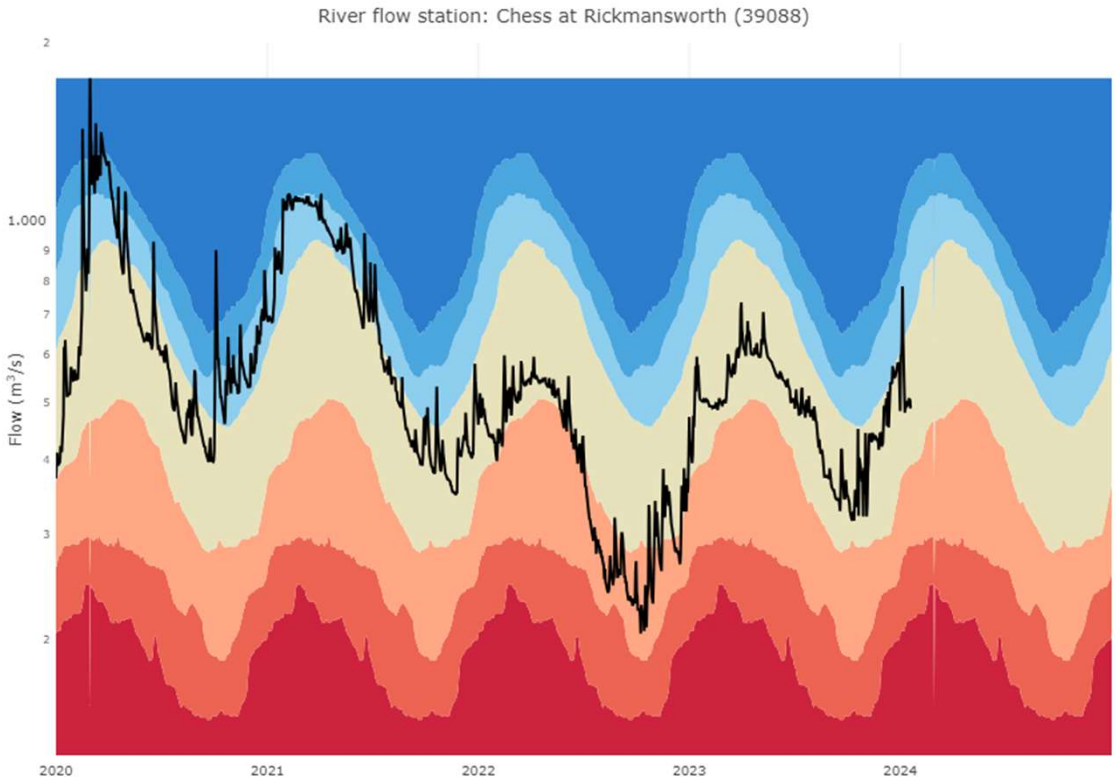
HOW DO THESE SPECIES INDICATE RIVER HEALTH?

Which is the odd one out?

LOW TO NO FLOWS IN RIVER CHESS

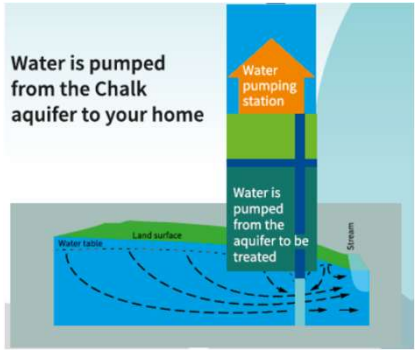


LOW TO NO FLOWS IN RIVER CHESS



SOURCE: UK Centre for Ecology & Hydrology 2023

HUMAN DISRUPTION TO THE DRAINAGE BASIN



Abstraction for drinking water

River channelisation

Domestic water use

Road runoff

Agricultural runoff

Plastic litter

BREAK FOR 10 MINS!

RESEARCH & TEACHING MATERIALS FOR 16+

Human Geography

Physical Geography

https://www.chilternstreams.org/learning/secondary/

Biology

Environmental Science

Resources

What is a chalk stream?

What is a chalk stream and what makes them so special? Watch our film to find out

Read more »

How do chalk streams work?

How do chalk streams work and why do they dry up? Watch our film to find out.

Read more »

Chalk streams in crisis

Chilterns Chalk Streams are under threat. Watch our film to find out more.

Read more »

River Chess Storymaps

Exploring the Chess as an environmental system and presenting real time dashboards This collection of storymaps presents background information on...

Read more »

Water management

Water Management: An enquiry-based learning scheme to explore the management issues associated with a chalk stream

Read more »

River Chess: Real-time Water Quality Dashboard

A series of water quality sondes were placed in the River Chess which record the following water quality indicators, providing live data at 15 minute intervals.

Read more »

Investigating the catchment hydrology of the River Chess

using groundwater and river discharge data

Read more »

Educational Posters

Download the posters As part of the ChessWatch project a series of posters were developed to explain more about human...

Read more »

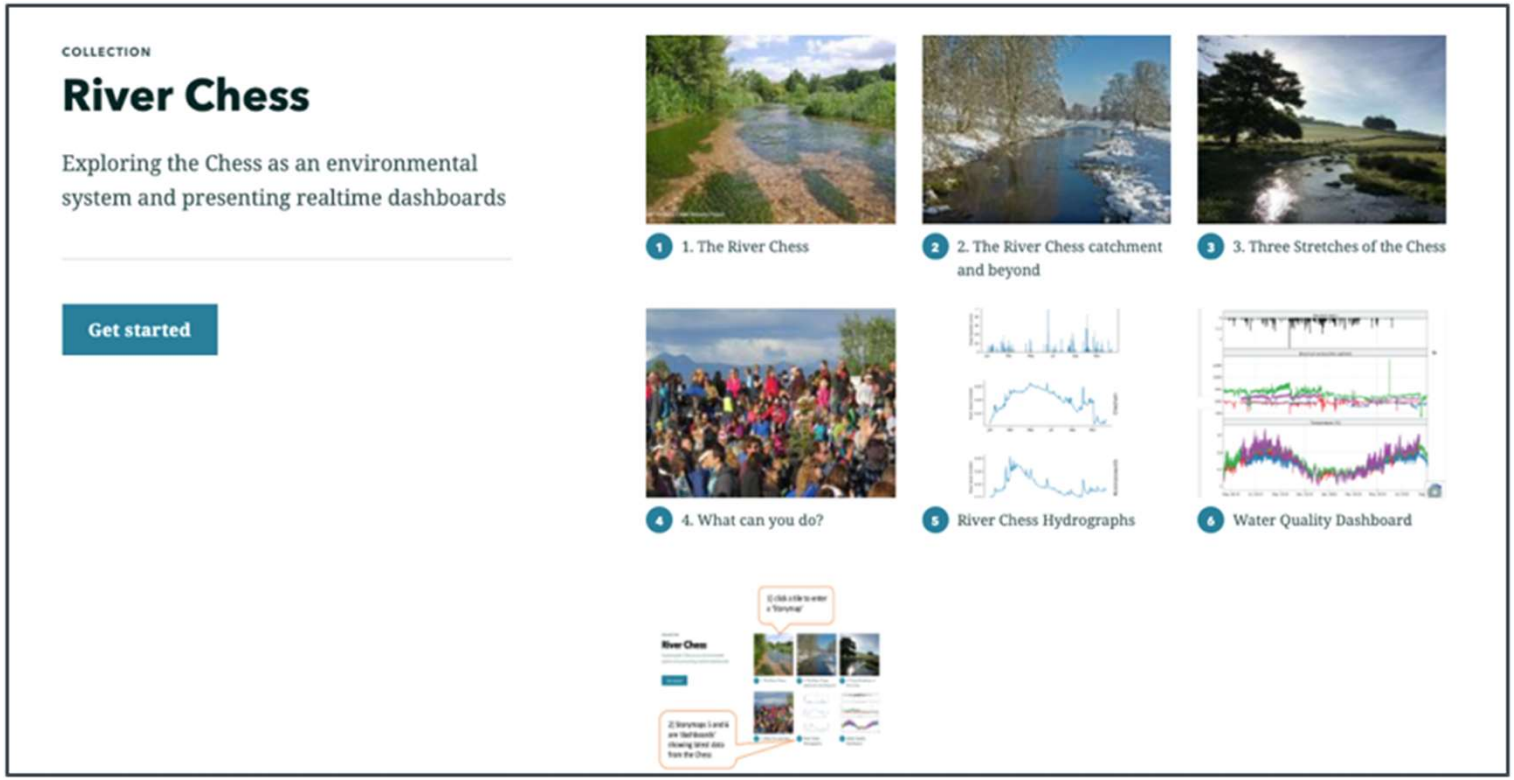
Back to Learning

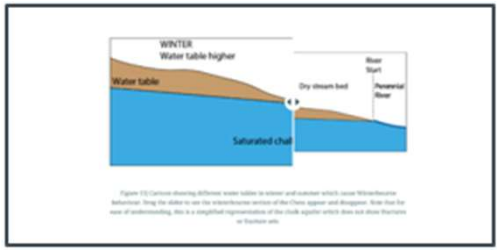
ENQUIRY-BASED LEARNING MATERIAL

- To understand the challenges of managing water resources in the urban catchment of the River Chess.
- To investigate and analyse the environmental, political, social and economic issues surrounding water management in the River Chess
- To evaluate the range of potential long-term solutions to managing water quality in a chalk stream
- To use skills of interpreting graphs, maps and a range of qualitative data to demonstrate an understanding of the complex balance of physical and human interactions in drainage basin management
- To present a report showing evidence of synthesising data to make valued judgements in water resource management.

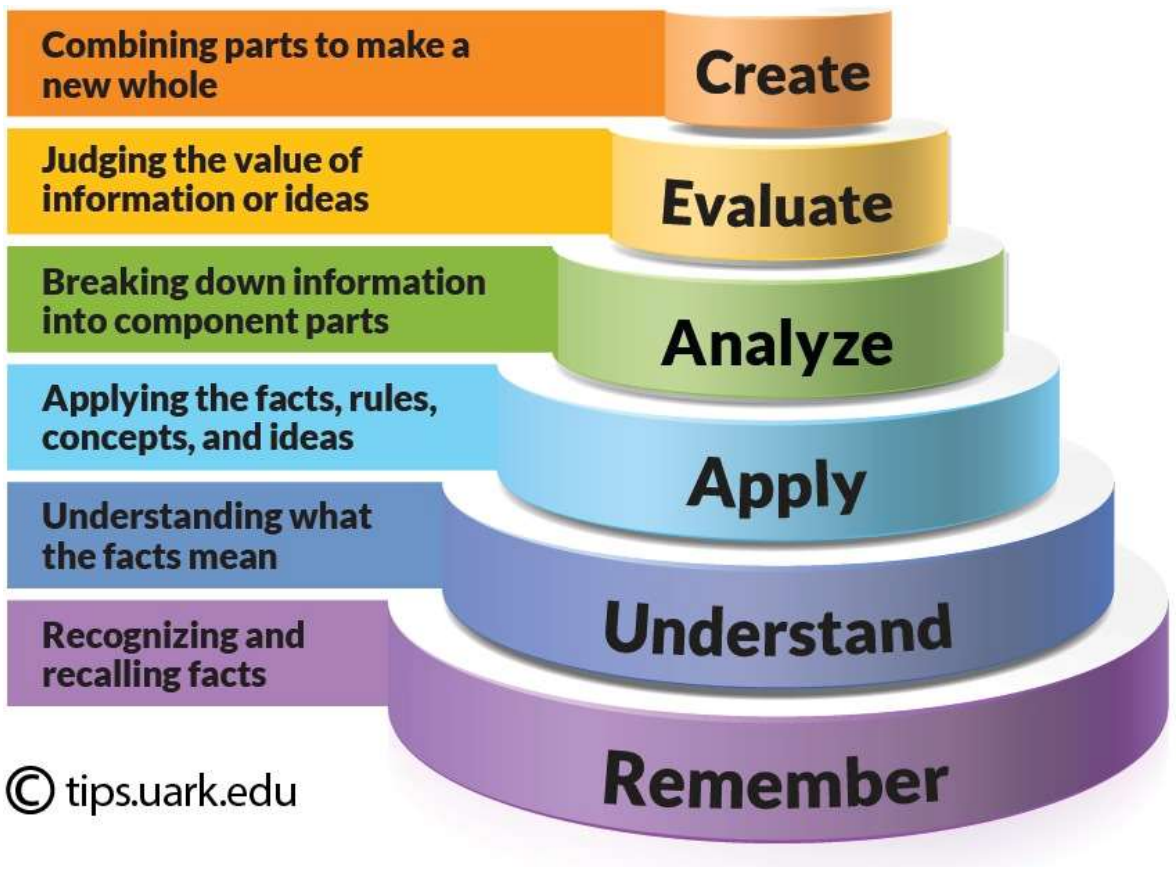
RIVER CHESS STORYMAP

http://chess-observatory.qmul.ac.uk

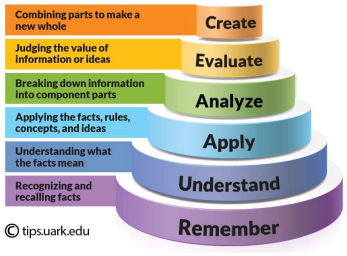




BLOOMS TAXONOMY



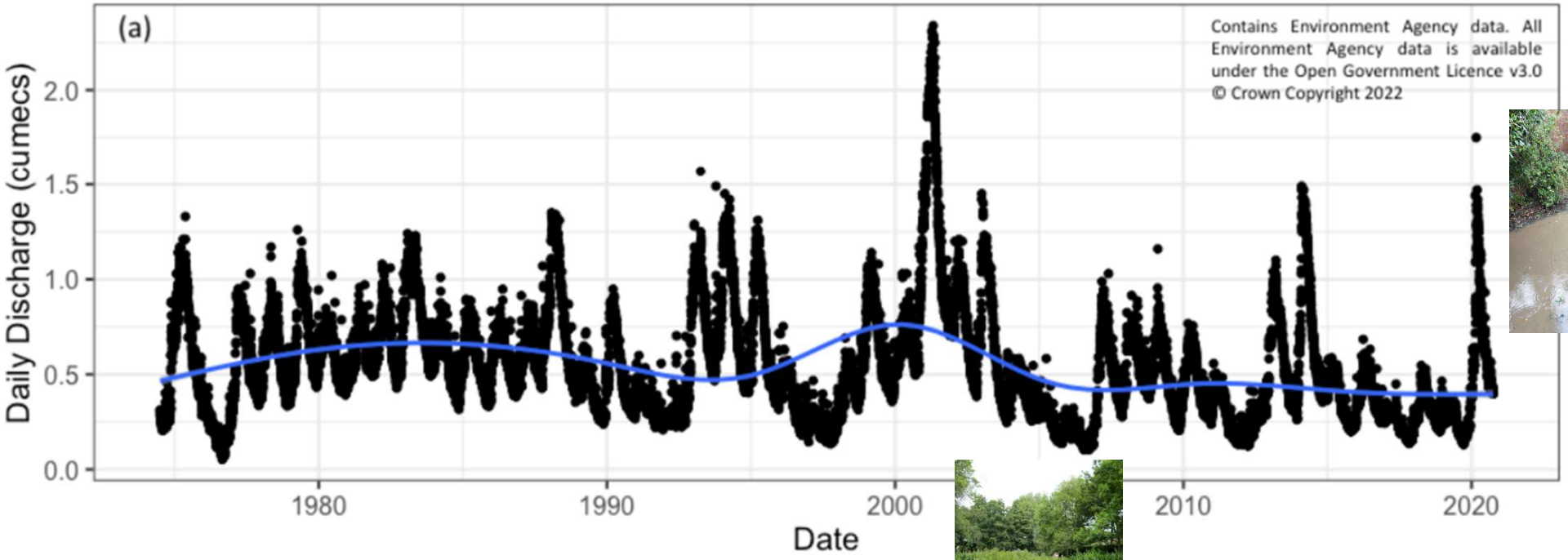
AN ENQUIRY INTO THE RIVER CHESS



AN ENQUIRY INTO THE RIVER CHESS						
I am using skills of …		**BLOOM calls this**	**Which involves**	**In essence**	**Question types and suitable activities**	
					Water ecology focus	**Sustainable water management focus**
Simple problem solving		**Application**	Using information in a new situation	Demonstrating how you can use data and skills	Drawing hydrographs Interpreting hydrographs Using Spearmans Rank to correlate groundwater and river discharge data	
Understanding		**Comprehension**	Making sense out of information	Explaining	Draw and annotate a diagram showing the factors controlling aquifer recharge and aquifer discharge	For River Chess catchment summarise the main reasons for rising water demand and falling water supply in recent years
Remembering		**Knowledge**	Recall	Facts	• 77% of chalk streams found to be below a good standard of health in 2014 • The chalk hydrological cycle has unique features • River Chess is in the Chilterns • River Chess is suffering from over abstraction, low flows, pollution and invasive species • Successful management involves holistic approach to problems called integrated catchment management	

Key					
	Teacher notes provided		Stimulus materials provided		Useful weblinks for student research

FLOWS IN THE RIVER CHESS



FLOWS IN THE RIVER CHESS

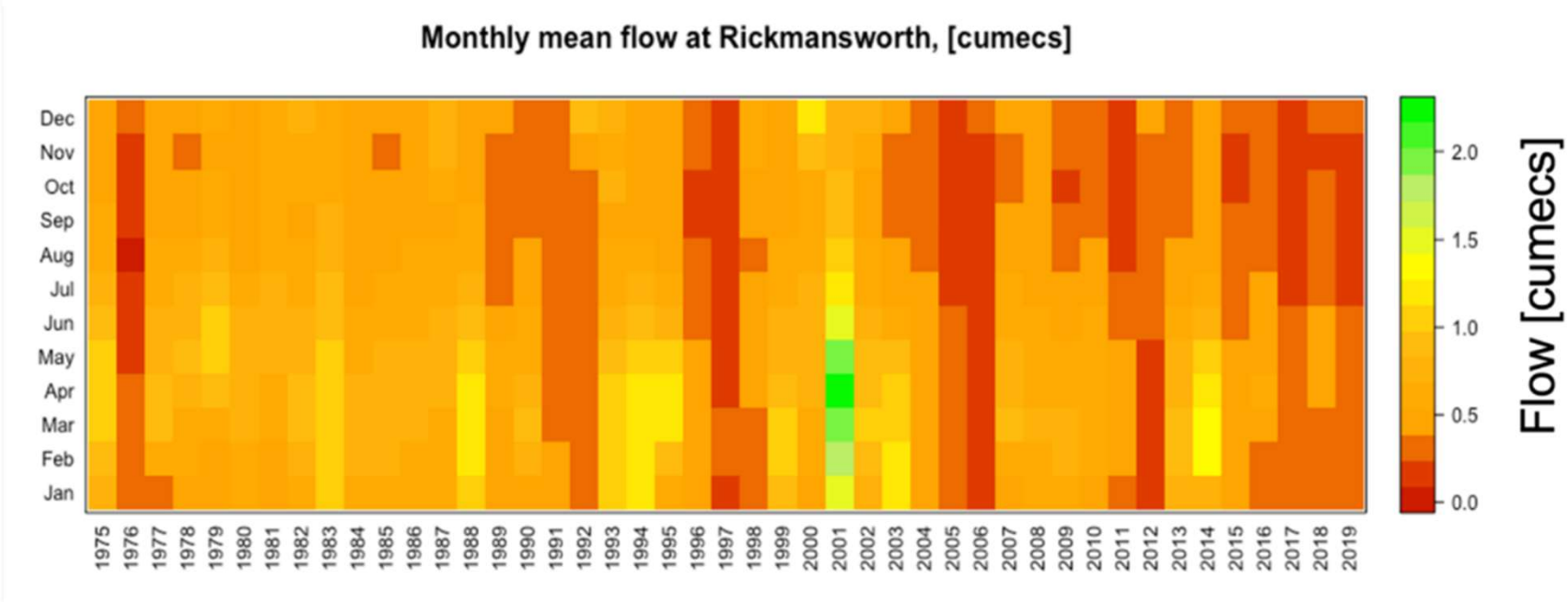


Figure 21 Heat map of mean monthly discharge (m3/s) at Rickmansworth gauging station. SOURCE: Environment Agency data.

WATER QUALITY SENSORS

Installed **water quality** sensors in the River Chess in April 2019 to measure:

- pH
- temperature
- electrical conductivity
- dissolved oxygen
- chlorophyll-a
- water level
- turbidity
- tryptophan

continuously logging at 15-mins intervals.

Select which variables you want to plot, and click "Update plots" to refresh the plots. The plots may take a few seconds to load.

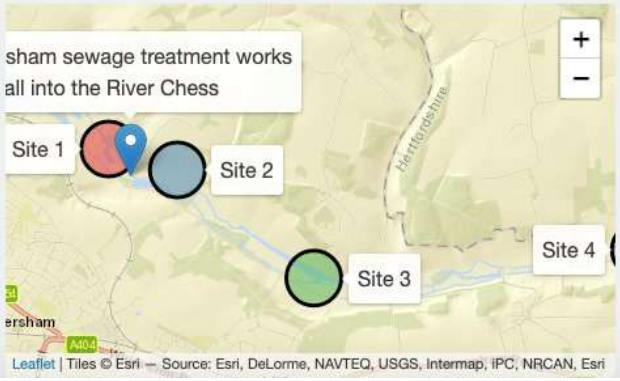
Choose measurements:

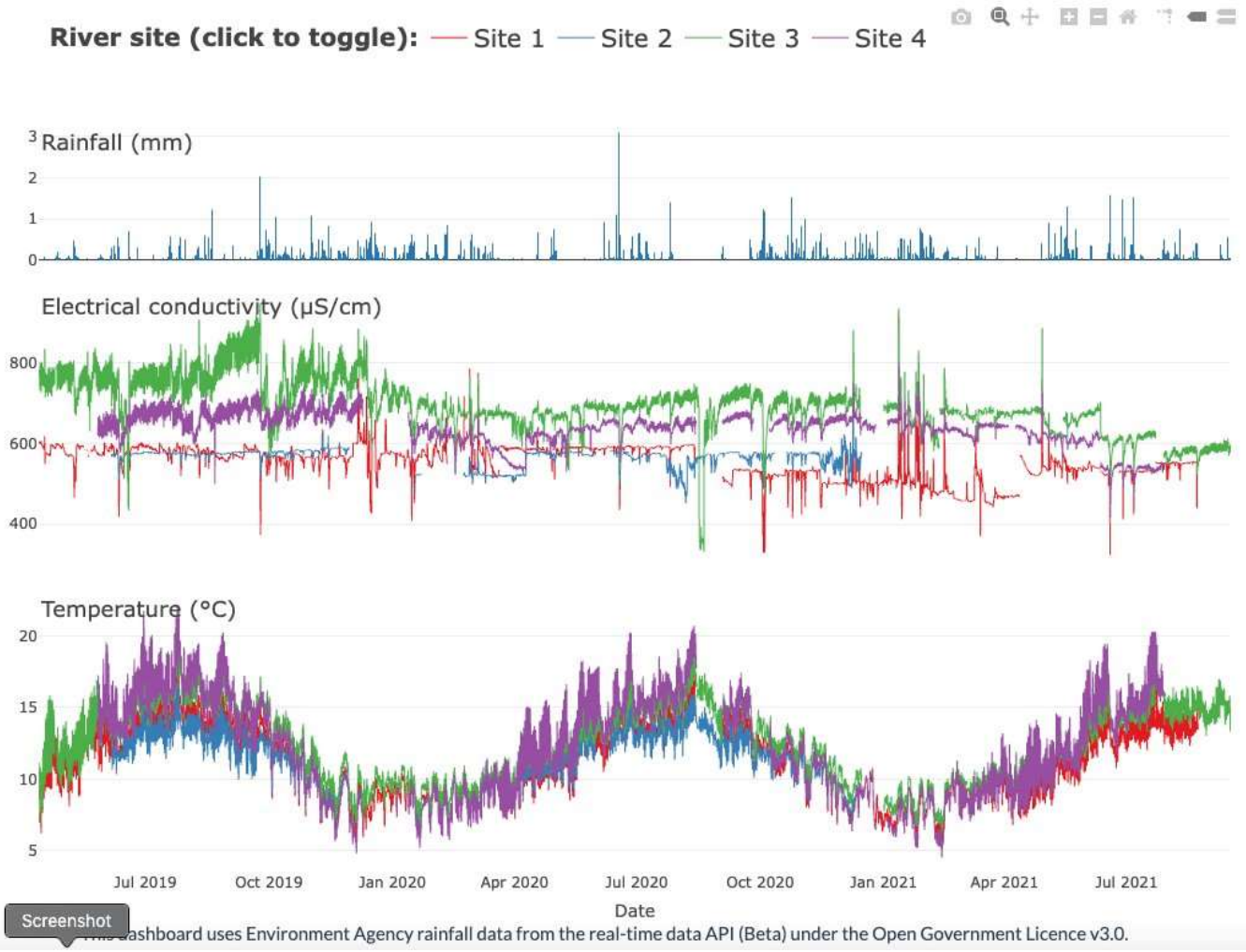
- [ ] Dissolved oxygen (% saturation)
- [ ] Dissolved oxygen (mg/L)
- [x] Electrical conductivity (µS/cm)
- [ ] pH
- [x] Temperature (°C)
- [ ] Tryptophan (RFU)
- [ ] Turbidity (NTU)
- [ ] Water level (m)

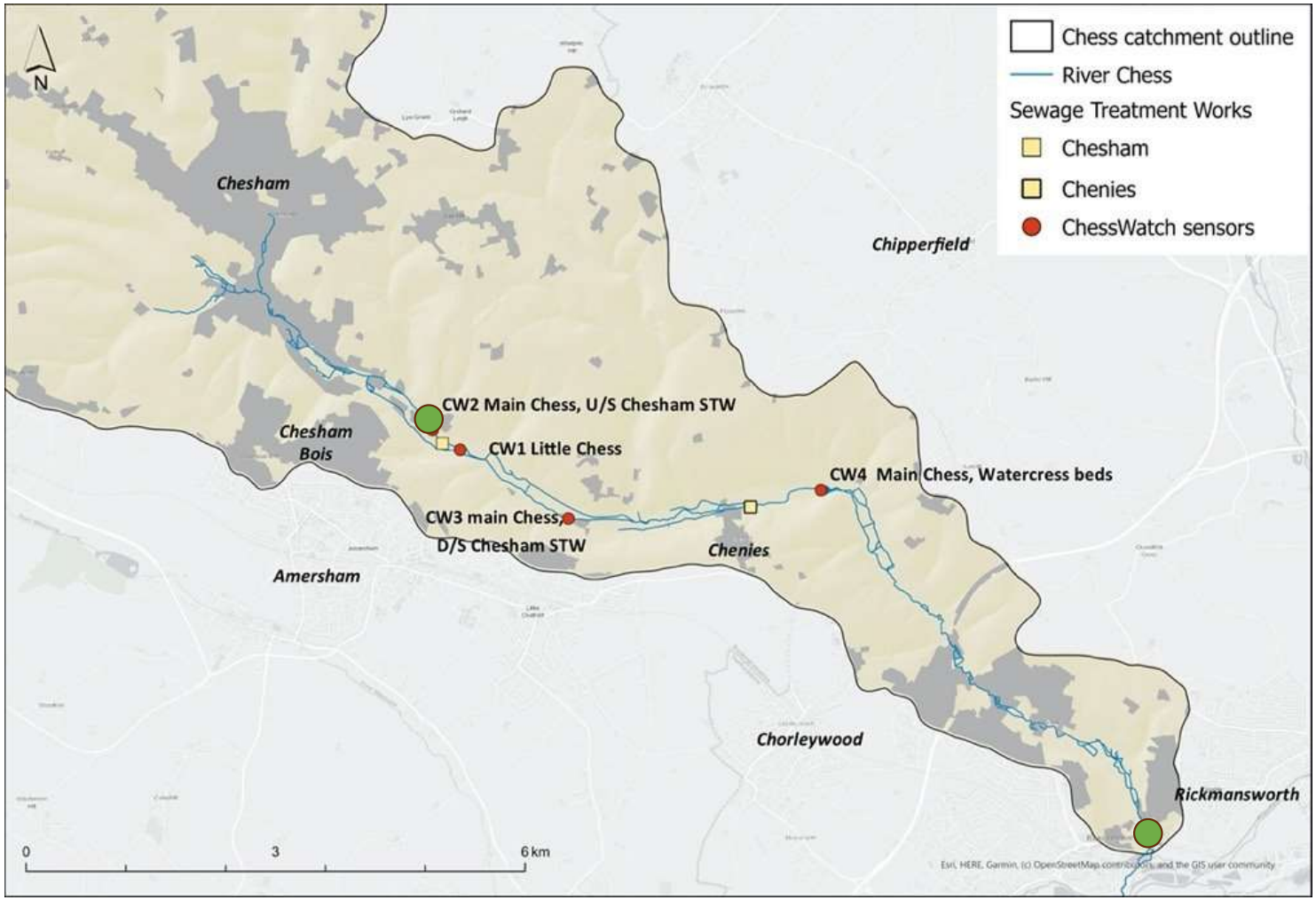
Select start and end dates:

Pick 2 dates

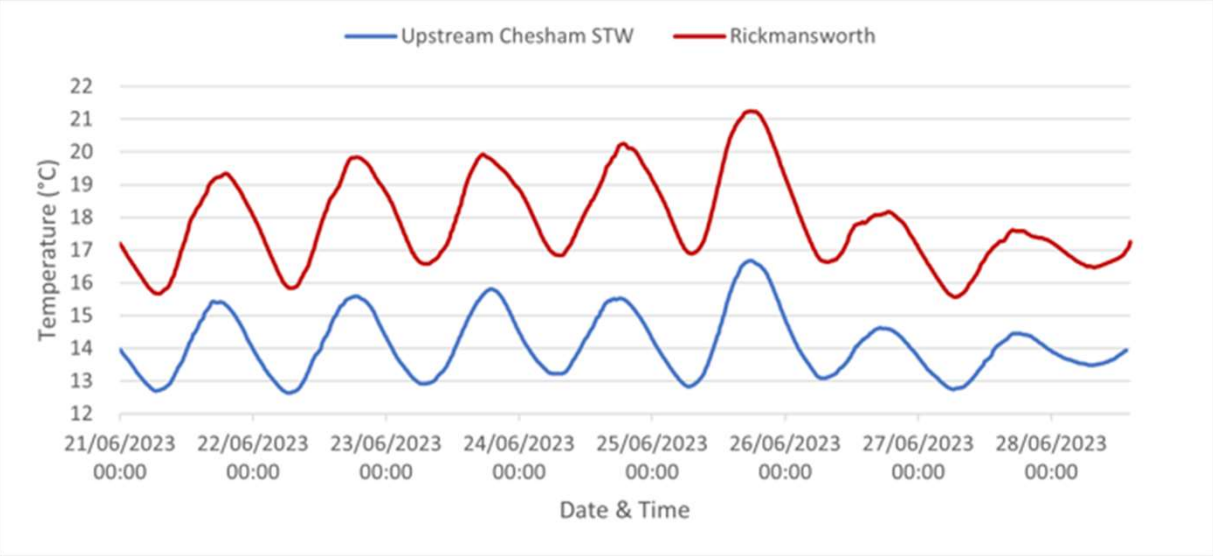
Cle Update plots ☐ Show events





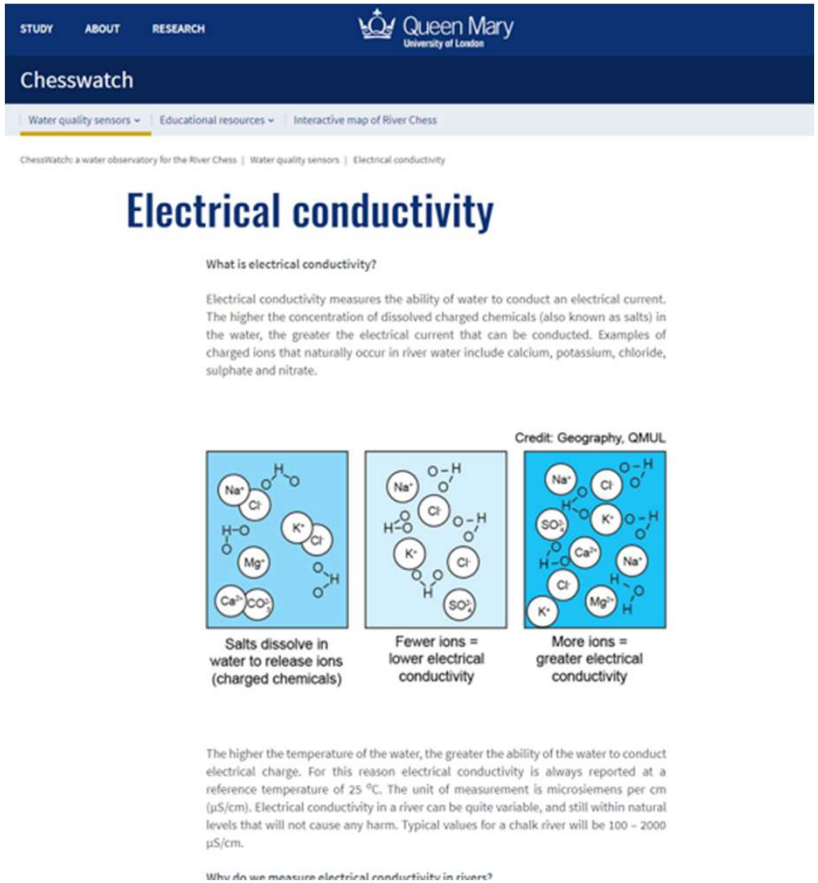

Chess catchment outline
River Chess
Sewage Treatment Works
Chesham
Chenies
ChessWatch sensors
N
Chesham
Chipperfield
CW2 Main Chess, U/S Chesham STW
Chesham Bois
CW1 Little Chess
CW4 Main Chess, Watercress beds
CW3 main Chess, D/S Chesham STW
Chenies
Amersham
Chorleywood
Rickmansworth
0
3
6 km

WATER TEMPERATURE



Chalk stream water temperatures emerge from the underlying aquifer at c. 10°C

OTHER WATER QUALITY MEASUREMENTS



STUDY ABOUT RESEARCH Queen Mary University of London

Chesswatch

Water quality sensors | Educational resources | Interactive map of River Chess

ChessWatch: a water observatory for the River Chess | Water quality sensors | Electrical conductivity

Electrical conductivity

What is electrical conductivity?

Electrical conductivity measures the ability of water to conduct an electrical current. The higher the concentration of dissolved charged chemicals (also known as salts) in the water, the greater the electrical current that can be conducted. Examples of charged ions that naturally occur in river water include calcium, potassium, chloride, sulphate and nitrate.

Credit: Geography, QMUL

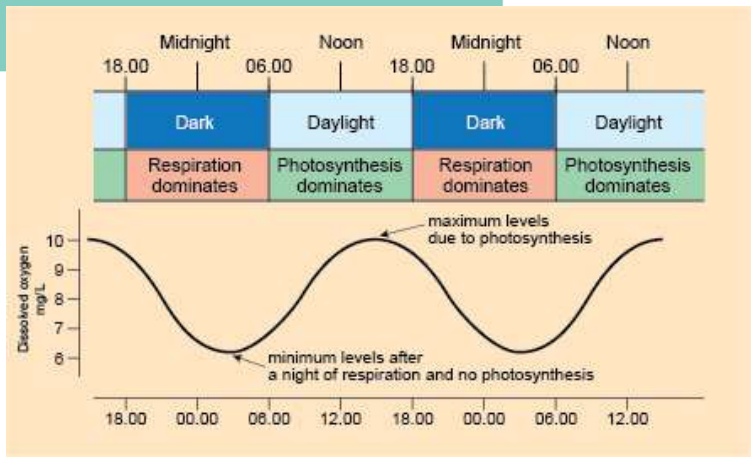
Salts dissolve in water to release ions (charged chemicals)

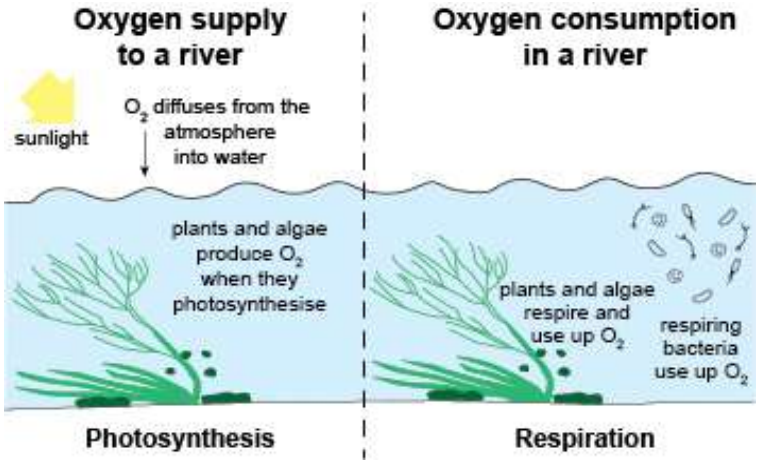
Fewer ions = lower electrical conductivity

More ions = greater electrical conductivity

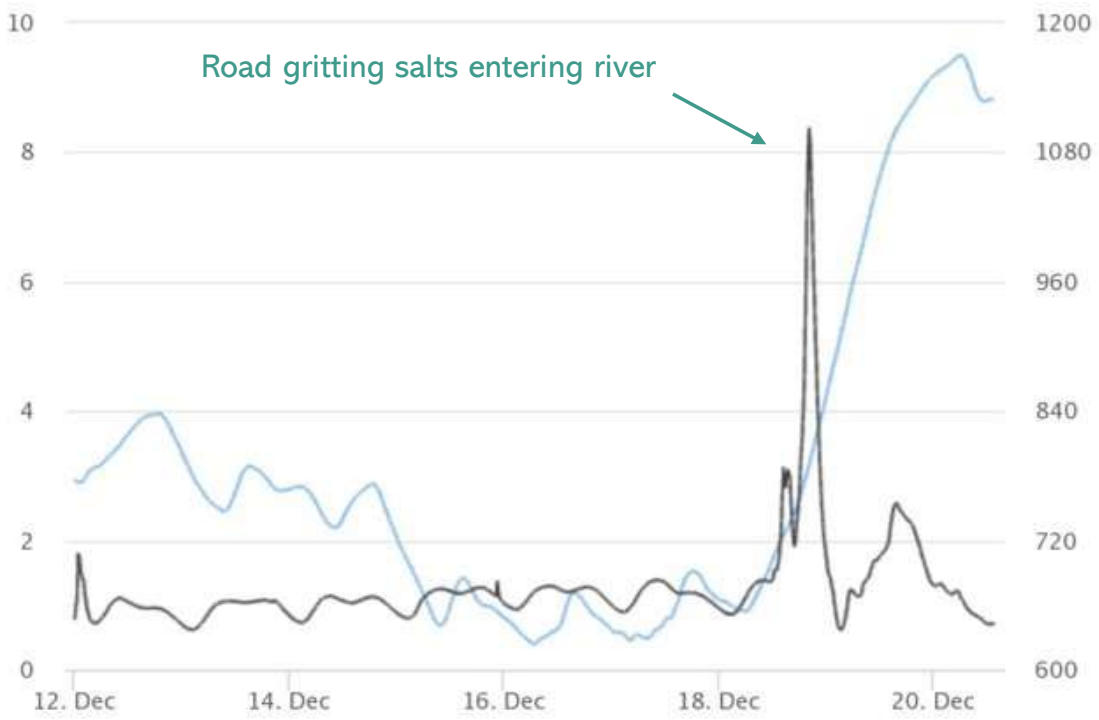
The higher the temperature of the water, the greater the ability of the water to conduct electrical charge. For this reason electrical conductivity is always reported at a reference temperature of 25 °C. The unit of measurement is microsiemens per cm (µS/cm). Electrical conductivity in a river can be quite variable, and still within natural levels that will not cause any harm. Typical values for a chalk river will be 100 – 2000 µS/cm.

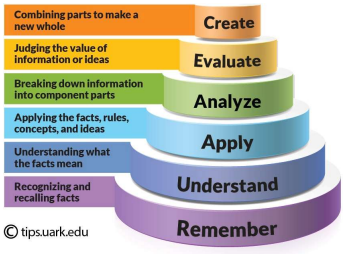
Why do we measure electrical conductivity in rivers?





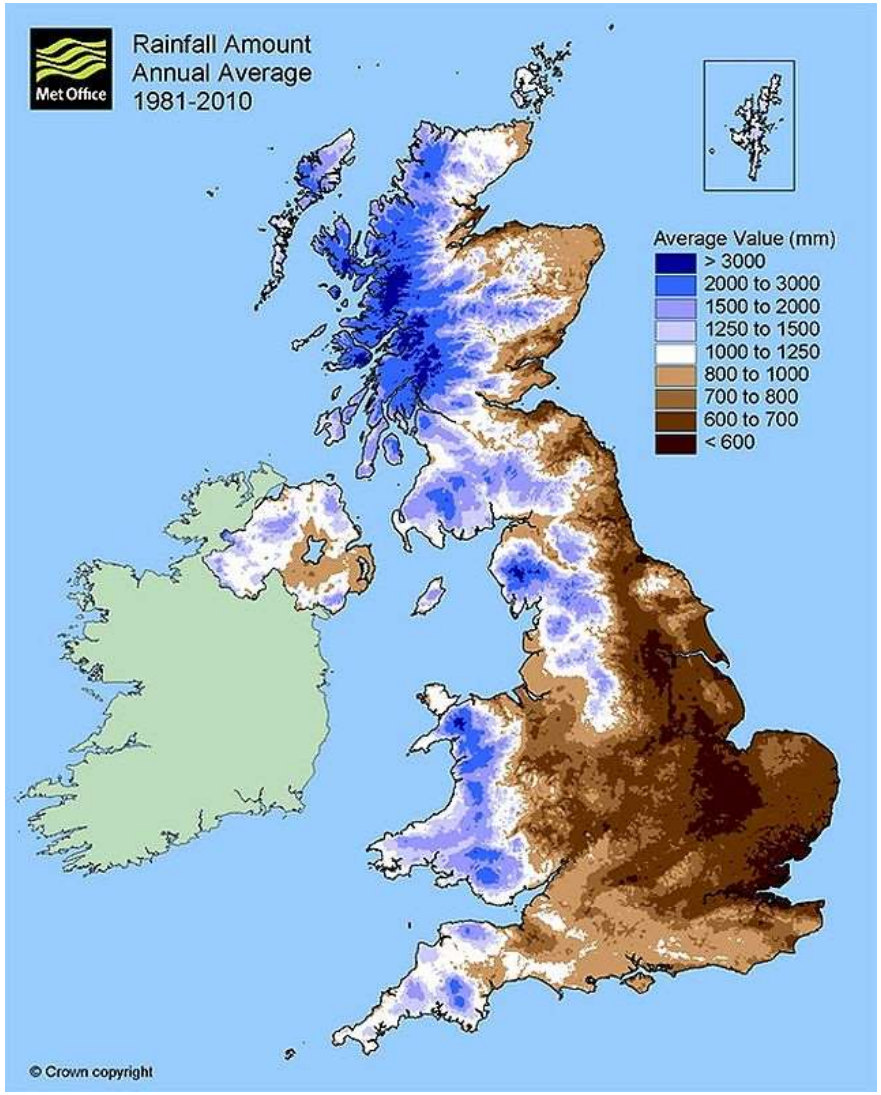
ELECTRICAL CONDUCTIVITY, ICE & SNOW





AN ENQUIRY INTO THE RIVER CHESS

I am using skills of …		BLOOM calls this	Which involves	In essence	Question types and suitable activities	
					Water ecology focus	**Sustainable water management focus**
Judgement and empathy		**Evaluation**	Critically examining information, making a judgement & justifying my opinion or understanding the opinions of others	Balanced arguments	Design an NEA project to assess the health of the River Chess.	Present a plan for sustainable water management in the R. Chess catchment which meets the needs of the present whilst safeguarding the needs of the future.
Planning and prediction		**Synthesis**	Putting new info & old info together	Creating	How do we know if the River Chess is healthy? Or Explain this statement *'I want to see water voles back, I want to see brown trout back and I want to see water cress back in production. It's simple!* 'Paul Jennings of the River Chess Assn, July 2019	Use SWOT analysis to present a report comparing the views of 6 different stakeholders on the River Chess.
Investigating		**Analysis**	Taking information apart, exploring relationships between factors	Unpicking	Choose two water observations from this list • pH • Dissolved oxygen • turbidity • Chlorophyll-a • Tryptophan • Electro conductivity • Water level / discharge Demonstrate an understanding of what is being measured Show the relationship between the factors	What are the main factors determining flow levels in the River Chess? Include both physical and human factors



Distribution of Rainfall over the UK

London receive less rainfall than Rome, Istanbul and Dallas and half as much as Sydney in Australia.

600 – 700 mm rainfall per year

Stimulus one: Water use in the UK

*These two companies deal with water and sewerage in the Chess catchment

		Average water use (litres per person, per day)		Leakage per property (litres per day)		Households with water meters (percentage of households)	
		2012 -13	2016 -17	2012 -13	2016 -17	2012 -13	2016 -17
Water and Sewerage Companies	**Thames***	154.7	146.4	174.7	178.7	32.5	37.7
	Anglian	136.2	135.7	89.1	85.1	73.1	79.7
	Southern	143.4	131.3	75.1	79.8	64.5	86.7
Water only companies	**Affinity***	148.5	154.8	129.9	116.0	47.3	52.2
	South Staffs	127.6	127.3	112.7	118.8	29.9	36.0

Comparison

On average the people of Denmark use 80L per person per day.

How water usage in the home breaks down 140 litres

Bathroom 56 L
Toilet 31 L
Cold water eg drinking 31L
Washing Machine 13L
Dishes 7L
Outdoor 3L

There is no doubt that we are on the verge of a water shortage crisis in the South and SE of England

Slate and Singleton -White, authors of **Chalk streams in Crisis** report 2019

WATER USE IN CHILTERNS REGION

- 8.8 million customers in the Thames region use 157 liters of water a day (2022)

- This is higher than the national average of 130 litres of water a day

- On average the people of Denmark use 80 litres of water per day

- 80% of water supply comes from rivers and 20% comes from aquifers / groundwater

- The amount we use affects the flow in our rivers.

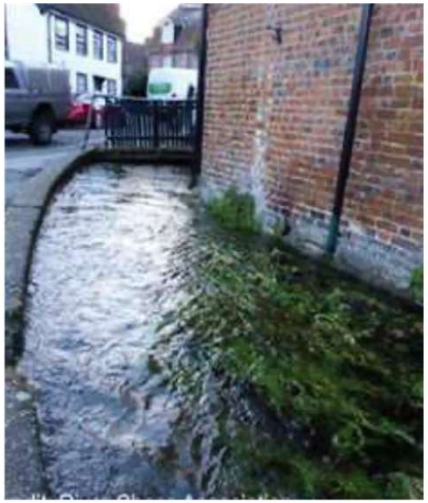
***What could you do to save water*?**
(Why) should you try to save water?

LOW FLOWS IN THE RIVER CHESS

'The worrying state of the Chilterns precious streams at present is mainly because last winter was so dry. Chalk streams rely on water held in the chalk aquifer for their flow and it is the rain that falls during the winter months (October to March) that soaks into the ground and replenishes the aquifer.' Chilternsaonb.org, 2017

The River Chess at the Queens Head, Chesham

These two photos show the same location at different times.

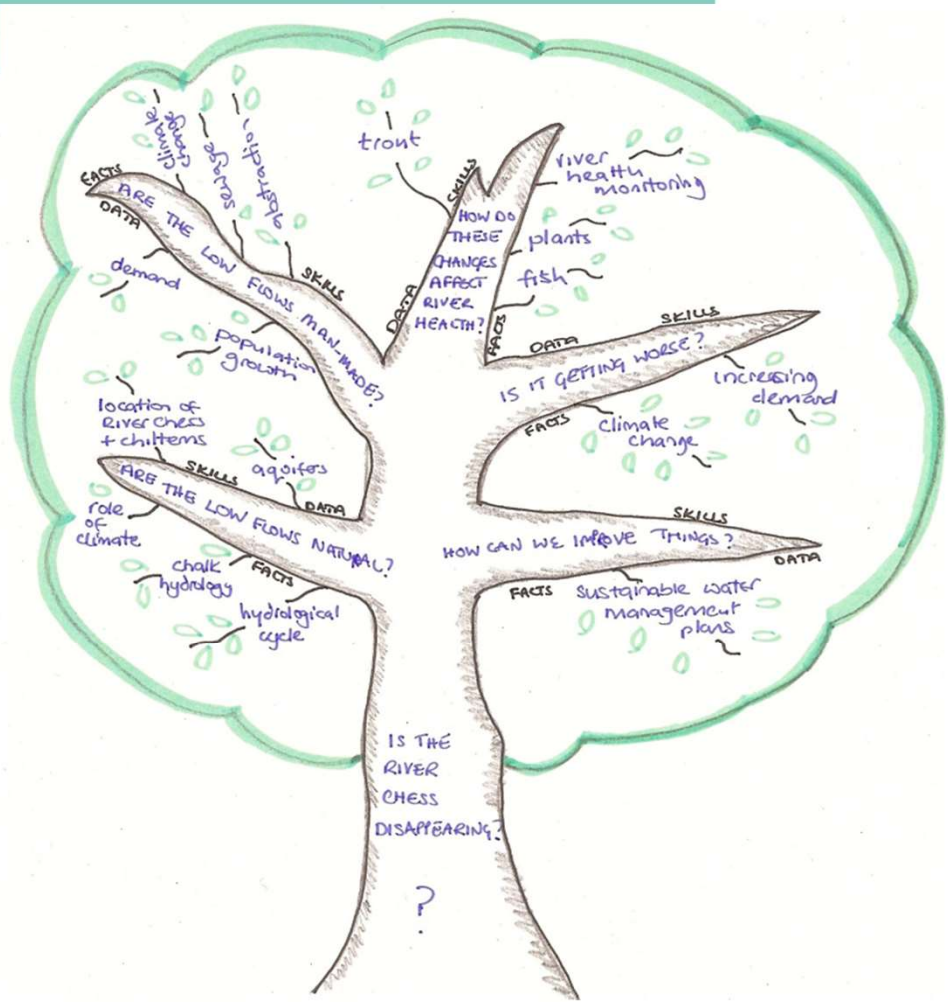


'All ten of the warmest years in the UK annual average temperature record have occurred since 1990, with the eighth warmest occurring since 2002' Elizabeth Kendon, Met Office 2015 as quoted in UK Climate Change Assessment 2016.

QUESTION PROMPTED BY WORKSHEET:
IS THE RIVER CHESS DISAPPEARING?

Work with your students to agree the question (like the trunk of a tree) and the key areas of investigation which will enable the class to get to grips with the enquiry question (like the branches of the tree).

Reminding students to ask ‘who’, ‘what’, ‘where’, ‘how’ and ‘why’ is helpful.



Lesson themes and module plan

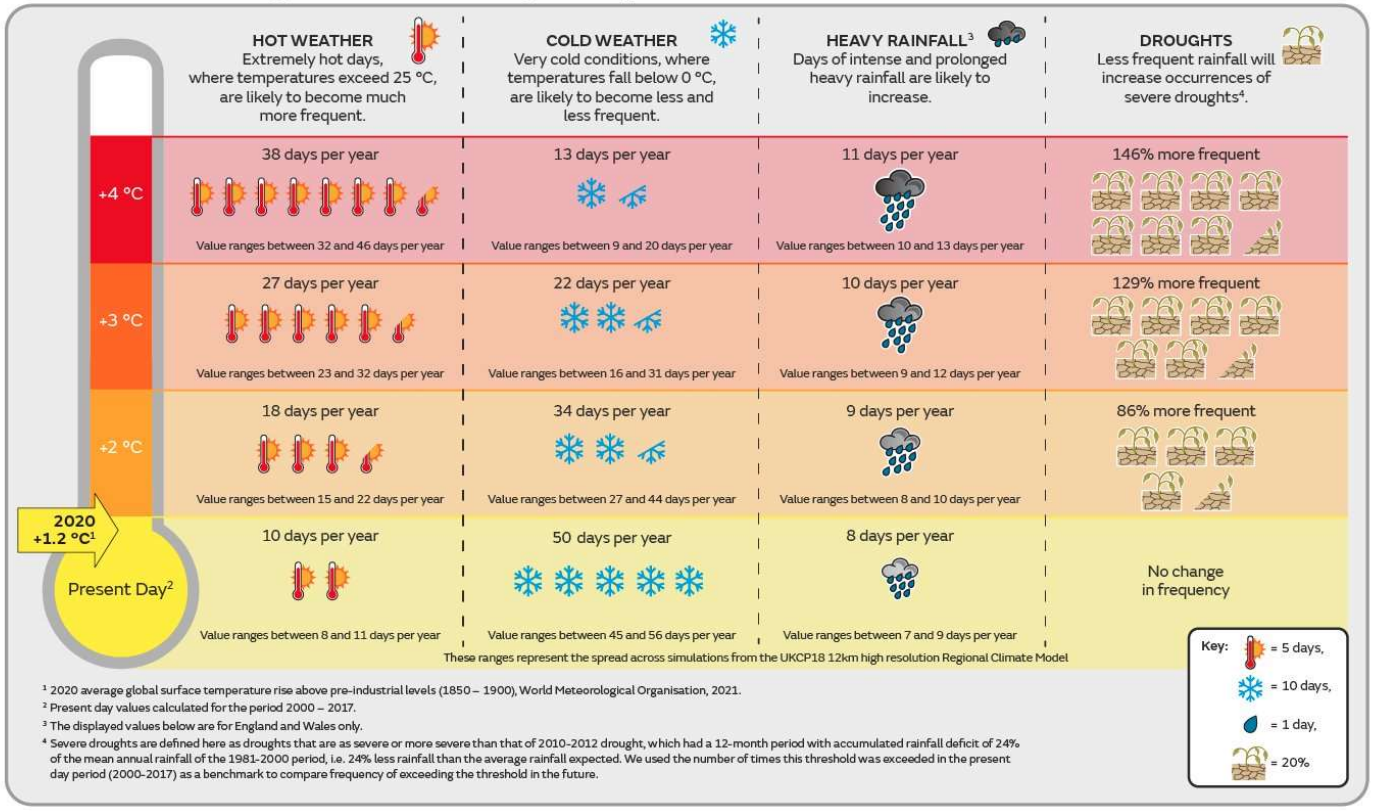
You might want to guide your students enquiry to cover certain themes or learning outcomes.

We have produced a module plan called 'Teaching the River Chess' to help you decide which aspects of the River Chess you might want to focus on with your students. The plan is divided into five different themes:

- Hydrology in chalk catchments
- River Health
- Human interactions in the drainage basin
- Managing water demand
- Creating sustainable water futures

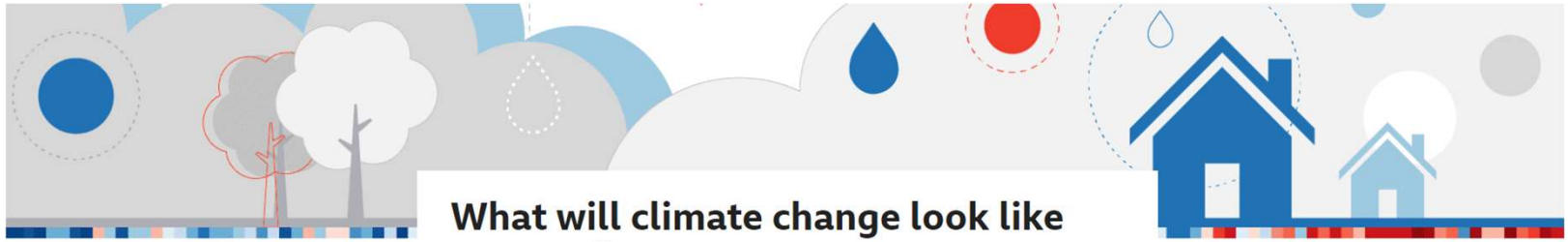
FUTURE PRESSURES ON THE CATCHMENT: CLIMATE CHANGE

Global warming and future high-impact weather in the UK



SOURCE: https://www.ukclimateresilience.org/resources/infographics/

CLIMATE CHANGE



What will climate change look like near me?

By Becky Dale and Nassos Stylianou | 12 August 2022 | Science & Environment

Animations on

How high might temperatures climb and how much rain might fall in your area and how? The BBC and the Met Office have looked at the UK's changing climate in detail to find out.

Temperatures in the UK exceeded 40C for the first time on record earlier this summer, and extreme weather events are likely to become even more frequent.

The Met Office climate projections cover different levels of global warming. When, or if, these levels are reached will depend on the concentration of greenhouse gases in our atmosphere.

The data is measured in 12km-square (7.5-mile-square) grids across the UK. The results for your postcode represent an average for the grids closest to you and the mid-point of a range of future possibilities, which come from the Met Office's most recent major climate modelling data.

SOURCE: BBC RESOURCE

https://www.bbc.co.uk/news/resources/idt-d6338d9f-8789-4bc2-b6d7-3691c0e7d138